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several occasions hooked *O. melania* with a small hook baited with a piece of seal blubber, but as a rule they decline to be taken in by any such means. Both *O. melania* and *O. socorroensis* will at times dive a foot or more below the surface for a piece of meat that is sinking if they are hungry, but diving seems to be out of their usual line of business and is only resorted to when food is scarce. They seem to be unable to get below the surface of the water without first rising two or three feet and plunging or dropping, exactly as I have seen the Black-footed and Short-tailed Albatrosses dive under similar circumstances.

THE ECONOMIC VALUE OF THE WHITE-BELLIED NUTHATCH AND BLACK-CAPPED CHICKADEE.¹

BY E. DWIGHT SANDERSON.

THE value of our common birds as insect-destroyers has of late years come to be recognized as an important field of investigation for the ornithologist and a large item in rural economy. Much valuable work has been done in determining their economic relations, but there has also been a large amount of assumption by various writers based on insufficient data. It is my purpose in this thesis to determine the character and amount of food and the economic relations of two of our most common residents, the White-bellied Nuthatch (*Sitta carolinensis* Lath.) and the Black-capped Chickadee (*Parus atricapillus* Linn.) from the analysis of the stomachs of 34 specimens of the former, and 28 of the latter, notes taken while collecting them, and incidentally from as much reliable data as could be found elsewhere.

METHOD OF ANALYSIS.

In no instance was any food found in the true stomach, mouth, or gullet, and the only part containing food was that ordinarily

¹ A Thesis submitted to the Faculty of the Michigan Agricultural College.

called the gizzard. This was removed and the contents carefully washed into a glass dish, in which it was spread out and examined under a dissecting microscope. The per cent of matter was determined by dividing the whole contents into various equal parts of the different components, as accurately as possible. In many instances the food was so finely divided that only its most general nature could be ascertained, and hence a stomach was often tabled as containing only one insect of a certain order when it doubtless contained the parts of many more, which were indistinguishable. Prof. E. H. Forbush states that Chickadees frequently pick out only the internal organs of larvæ, and as these are easily digested and not individually recognizable, such work would escape observation. The seeds were kindly determined, as far as their mutilated condition would permit, by Prof. C. F. Wheeler and Prof. W. B. Barrows, while many of the eggs were identified by Prof. Th. Pergande of the Division of Entomology, U. S. Department of Agriculture, to all of whom I wish to express my indebtedness. Very little of the insect food could be named further than given, with any degree of accuracy, and often it was impossible to determine anything below the order.

The specimens were all collected within a radius of five miles from the college. Record was kept of the sex, but no difference in the feeding habits was noticed, although most of the Nuthatches were secured in pairs. Notes upon the weather were also kept, but specimens were secured under all conditions,—both during a bright February thaw and a March snow-storm, and except as caused by the ground being covered with snow, no difference could be seen, save as noted between different periods. Neither did the time of day seem to cause any variation.

WHITE-BELLIED NUTHATCH. (*Sitta carolinensis* Lath.).

Thirty-four stomachs were secured, of which 23 were collected during the winter season (Jan. 14 to Feb. 24), snow covering the ground much of the time; while the last eleven were secured during the spring (April 10-17), before the foliage was out. The contents were tabulated and two totals made, showing the difference in seasons. I had wished to secure specimens during the

early summer for further comparison along this line, but as the birds were becoming very scarce near the college and little time was available for the work, I was unable to do so. Such a series would doubtless give some interesting data.

Vegetable Food.

Misled by the name, it has always been stated that Nuthatches feed on the kernels of nuts which they break open. I was fortunate enough to secure one specimen while 'hatching' an acorn, which was done at the apex, and secured the fruit. It had been cracked in two, and was quite wormy. Careful analysis of the vegetable matter found in the stomachs—even by microscopical sections—failed to reveal a trace of any acorn meat (but showed that supposedly acorn to be Indian corn), and furthermore it would seem that if that was desired, a sound specimen would have been selected by the bird. In view of these considerations, I am led to believe that the nuts—such as acorns and beechnuts—are sought merely for the insects which they contain.

During the winter the larger portion of the food was composed of seeds, which gradually decreased as insect life became more abundant. Those determined were: *Zea mays* in twelve stomachs, *Ambrosia artemesiaefolia* in eight, and two *Helianthus* sp? Numerous other seeds were so badly broken as to be undeterminable. All were digested, and none, whether of noxious or beneficial plants, were consumed in quantities of any economic importance.

Insect Food.

A remarkable increase in the per cent of insect food is seen in the second series over the first, it forming 79.5 per cent in the spring, while only 25.7 during the winter. Seeds, on the other hand, were just the reverse, forming 67.4 during the winter and only 13.5 in the spring. The proportion of gravel remained comparatively constant at 6.2 and 7, as did also the amount of food at an average of .8 c.c. and .84 c.c. for the respective periods. In the latter series all the insects were adult, while in the former almost one-third were eggs or larvae.

Hemiptera, largely *Piesma cineria*, were the most important insects in the first series; with Coleoptera next. These two orders made up the bulk of insect food during this period with the exception of a single stomach which contained some 25 Myrmicidæ. During the second period, Hymenoptera were found in considerable numbers, all being beneficial, and with about equal parts of Perlidæ and Coleoptera constituted the greater part of the insect food.

In the latter period there seemed to be a tendency to take larger insects, as evidenced by several good sized moths, which of course would lessen the number of individuals. Though the number of the insect forms eaten by the Nuthatches is comparatively small to that of those eaten by the Chickadees, yet it is no doubt due to the fact that their insect food is much more rapidly digested by the aid of the gravel, than in the Chickadees, which have none.

The following list gives in detail the insect matter found in the individual stomachs: Numbers 1, 7 and 8 were collected on Jan. 19; 9, 10, 11 and 14 on Feb. 2; 20 on Feb. 10; 21, 22, 23, 24, 25 and 26, on Feb. 16; 29, 30, 31, 32, 33, 34 and 35 on Feb. 20; 43 on Feb. 22; 41 on Feb. 24. (It will be noticed that the numbers are not consecutive.) 44 to 52 inclusive on April 10; 56 and 57 on Apr. 17. Only those partially or completely identified are listed, while the totals include the whole contents.

List of Insects Found in 34 Stomachs of the White-bellied Nuthatch.

Hymenoptera: Evanidiæ, 1 in No. 45; Braconidæ, 6 in Nos. 46, 47, and 48; Tenthredinidæ, 1 in No. 47; Formicidæ—*Myrmica* sp?—25 in No. 22. Winter, 27 adults; spring, 14 adults. Total Hymenoptera—51 adults in 7 stomachs.

Lepidoptera: Tineidæ—*Bucculatrix* sp?—1 pupa in No. 22. Winter, 1 pupa; spring, 4 adults. Total Lepidoptera—adults, 4; pupæ; 1, in 5 stomachs.

Diptera: Muscidæ, 2 in No. 7; Syrphidæ, 1 in No. 49. Winter, 2 adults; spring, 4 adults. Total Diptera, 6 adults in 4 stomachs.

Coleoptera: Carabidæ, 3 in Nos. 56 and 42—*Harpalus* sp?—4 in Nos. 7 and 8;—*Pterostichus* sp?—2 in No. 32; Elateridæ, 1 larva in No. 7; Buprestidæ, 1 adult in No. 41; Scarabidæ, 1 adult in No. 48. Winter, 17 adults, 22 larvæ; spring, 12 adults. Total Coleoptera—adults, 29; larvæ, 22; in 25 stomachs.

Neuroptera: Perlidæ, 23 in Nos. 32, 31, 43, 51 and 52; Libellulidæ, 1 in No. 45. Winter, 9 adults; spring, 17 adults. Total Neuroptera — 26 in 7 stomachs.

Hemiptera: Tingitidæ. *Piesma cineria*. — 37 adults in 8 stomachs; Reduviidæ, 22 eggs in Nos. 11 and 24; Coreidæ, 2 adults in No. 10; Jassidæ, 7 adults in Nos. 14 and 45. Winter — 46 adults, 21 eggs; spring, 5 adults. Total Hemiptera — adults, 51; eggs, 21; in 13 stomachs.

Orthoptera: 4 in Nos. 8 and 10 (winter), Nos. 45 and 48 (spring.)

Total Insect Forms — Winter, 101 adults, 1 pupa, 22 larvæ, 21 eggs; spring, 60 adults. Adults, 161; pupae, 1; larvæ, 22; eggs, 21; = 215. Arachnida, 7. Winter, 4; spring, 3.

A glance at the list will show that almost no well known injurious insects were found, the most common noxious form being *Piesma cineria*, which never does any considerable injury. As mentioned, one stomach contained a *Myrmica* sp? which possibly may be considered noxious. On the other hand, a large number of beneficial forms, such as Braconids, Reduviids and Carabids were found, and many that may be considered neutral as Perlidæ — and even those might be considered as valuable in the larval stage for fish food.

Thus it is seen that the insect food is taken more or less indiscriminately and that the beneficial forms fully equal those more or less injurious, while there were none found feeding upon any insect pest.

Habits.

The birds are invariably found in pairs; in only one instance did I find half a dozen together on a river bank, which doubtless were several pairs. The timber in this neighborhood consists of small lots of a few acres and each of these will ordinarily be occupied by only one pair of Nuthatches. They invariably feed upon rough barked trees; half of my specimens being taken on elms, with almost equal parts of the majority of the remainder on ash and oak. Three specimens were secured in an old apple orchard quite distant from any dwellings, and no others were found around fruit trees, possibly on account of the aforesaid preference for rough barked trees.

Abundance.

The abundance of the individuals or aggregate number per square mile is very difficult to determine. I generally secured about three for every two miles travelled. As I generally covered a radius of a quarter-mile each way from the straight line over the country travelled, I should think about five per square mile would be a fair average for this portion of the State. This would also, without doubt, be a fair sample of the greater part of the State, as there is only a moderate amount of bird life in this section. At Ithaca, N. Y., Mr. F. H. King found one for every two miles travelled.

It is to be regretted that I have been unable to secure any specimens from any infested orchard, so as to ascertain whether or not they will eat the most abundant food offered them.

Partial Domestication.

They have become very tame upon the campus and frequent the doors of the boarding-clubs, where they feed upon the refuse scraps. A pair of these have frequently been seen upon a porch-roof below my window, where they were feeding on the meat left in walnut shells, fruit, parings, and other refuse dropped there, and they would often come up and perch on the window sill. This would go to show that where protected, they would become permanent residents, quite soon, as they are not naturally of a timid disposition. Many authorities consider them highly beneficial, in fact class them with the Chickadees, but with the exception of their being found eating *Mytaspis pomorum* by Professor Forbush in Massachusetts, there seem to be no satisfactory notes or data upon which to base this assumption.

Value.

Though, in view of these facts, I should desire to experiment somewhat with them in an infested orchard, before declaring them to be merely neutral, yet from all the data secured there would

seem to be but little doubt that the Nuthatch, both from its food and habits, is either absolutely neutral or of comparatively small economic importance.

BLACK-CAPPED CHICKADEE. (*Parus atricapillus* Linn.).

Twenty-eight stomachs were secured; the first nineteen during the winter, and the last nine in the spring, being the same periods in which the Nuthatches were collected. The contents were tabulated as for the Nuthatches.

Vegetable Food.

During the winter 39.3 per cent of the food was vegetable, though one-third of the stomachs contained no seeds whatever, while in the spring the food was wholly insect. The seeds identified were one *Avena sativa*, and one *Ambrosia artemesiaefolia*, being practically the same as those upon which the Nuthatch fed.

Difference in Food as Affected by Season.

The same increase of insect food in the spring over that in the winter is seen as for the Nuthatch. During the winter 70.7 per cent of the food was animal, while in the spring no vegetable matter whatever was eaten. No trace of gravel was found in any of the stomachs. This is doubtless due to the small amount of vegetable food eaten, removing the necessity of a large amount of grinding to bring the food into a digestible condition. The total amount of food also remained nearly constant, being .48 c.c. in the winter and .53 c.c. in the spring. Even more markedly than in the Nuthatches, it is seen that in the spring far more adults, in comparison with the number of eggs and larvæ, were eaten than in winter. Whereas in the winter about $\frac{2}{3}$ of the insect forms were adult, $\frac{1}{3}$ larvæ, and $\frac{1}{3}$ eggs; in the spring, $\frac{1}{2}$ were adult, $\frac{1}{10}$ larvæ, and $\frac{1}{2}$ eggs. While the total bulk of the food in the spring was $\frac{1}{10}$ larger than that of the winter, yet there were over sixty times more forms eaten in the winter than in the spring, which was largely due to the enormous number of Reduviid eggs then

consumed. The fact that the spring larvæ had not yet emerged to any extent and that the adults were becoming active must also be carefully considered.

Character of Food.

Hemiptera, eggs and adults, formed by far the greater part of the food of the first period, with Coleoptera and Lepidoptera next, or possibly from an economic standpoint of equal importance. During the second period, the greater part of the food was adult beetles, with a large portion of adult Lepidoptera. In two stomachs, parasitic worms of considerable size were found. One was of a small, white and cylindrical form, while the other was white, but more flattened, with longer segments, and a true tape-worm.

Several well known insect pests were found in considerable numbers. Among them, four—*Bucculatrix* sp?—pupæ in two stomachs; 62 Noctuid larvæ in five; 105 Coleopterous boring larvæ in two; 15 *Aphis mali* eggs in 28; and 77 *Mytilaspis pomorum* scales in four stomachs. (Each of the latter doubtless covered fifty to seventy-five eggs.) The only beneficial forms found were nine adult Carabidæ in four stomachs and possibly the 450 Reduviid eggs secured from twelve stomachs may also be so considered, but the amount of their value is very uncertain. Thus it is seen, that injury done by eating beneficial insects is very small and of doubtful amount, while almost the entire food is composed of more or less noxious forms. The injurious forms were also eaten in large numbers, showing that the bird would be of considerable value toward their removal when placed among a large number of them, and undoubtedly would be especially useful in destroying a pest during the winter season. In fact, Prof. Forbush has shown by actual experiment (Mass. Crop Report, July, 1895, Ser. '95, Bulletin No. 3. Noticed in Auk Vol. XII, p. 383, 1895) that when these birds are present in the winter the destruction of the eggs at that time rendered it possible for the summer birds to destroy all the larvæ during a severe attack of the canker-worm, and the orchard thus produced a good yield, whereas elsewhere the trees were largely defoliated. The

following list gives the contents in detail: Numbers 2 and 3 were secured on Jan. 19; 4, 5 and 6 on Jan. 20; 12, 13, 15, 16, 17 and 18 on Feb. 21; 27 and 28 on Feb. 16; 36, 37, 38, 39 and 40 on Feb. 24; 42, Feb. 25; 53, 54, 55, 58, 59, 60, 61, 62 and 63 on Apr. 17.

List of Insects Found in 28 Stomachs of the Black-capped Chickadee.

Lepidoptera: Tineidæ—*Bucculatrix* sp?—4 pupæ in Nos. 28 and 40; Ennomidæ—*Ennomos magnarius*,—27 eggs in Nos. 27 and 39; Noctuidæ—1 *Catocala* (?)—egg in No. 27, 62 larvæ in Nos. 2, 16, 27, 28 and 38. Winter, 6 pupæ, 66 larvæ, and 26 eggs; spring, 6 adults and 1 larva. Total Lepidoptera: adults, 6; pupæ, 6; larvæ, 67; eggs, 26; in 9 stomachs.

Diptera: Adults, 1; larvæ, 7; in 4 stomachs. All in winter.

Coleoptera: Carabidæ.—9 adults in Nos. 6, 15, 40, and 43; Scarabidæ, 3 adults in Nos. 53 and 60; Cerambicidæ, 2 pupæ in No. 39; boring larvæ, 105 in Nos. 27 and 28. Winter, 29 adults, 2 pupæ, and 118 larvæ; spring, 18 adults. Total Coleoptera—adults, 7; pupæ, 2; larvæ, 118; in 16 stomachs.

Orthoptera: 3 eggs in No. 12. (Winter.)

Hemiptera: Tingitidæ—*Piesma cineria*—3 adults in Nos. 27 and 42; Reduviidæ, 450 eggs of two species in 12 stomachs; Pentatomidæ—*Stiretrus anchorago*—7 eggs in No. 5; Aphidæ—*Aphis malii*—15 eggs in No. 28; Coccidæ—*Mytilaspis pomorum* scales, 77 in Nos. 15, 18, 27, and 39. Winter, 108 adults and 461 eggs; spring, 5 adults. Total Hemiptera—adults, 93; eggs, 466; in 15 stomachs.

Total winter, 125 adults, 8 pupæ, 193 larvæ, and 504 eggs; spring, 24 adults, 1 larva, 5 eggs; in 15 stomachs. Total Insect Forms—adults, 149; pupæ, 8; larvæ, 194; eggs, 494 =845. Arachnida, 25.

Habits.

The Chickadee's habits of life also commend them as being beneficial. They are usually found in small flocks of from six to a dozen, of which the larger number are females. These often mix with those of Goldfinches and Tree Sparrows, or are found in company with a pair of Nuthatches, during the winter, but become more independent as spring advances and there is an abundance of bird life all about them. Over half of my specimens were secured in bushes on low, damp, marshy ground, or along a creek or roadside. They often descend to the ground in marsh land

and scratch among the dead rushes for any insects there. I am inclined to think that most of the Reduviid eggs were secured on such marshy ground. Tamarack was a favorite resort with many. About one-fourth were taken from oak trees, but on these they searched for insects upon the tips of the smooth branches, rather than on the rough trunk as do the Nuthatches. Two were secured in an apple orchard, while five others were seen coming from one. Many times they were seen in orchards near dwellings, where I was unable to secure them by use of the gun. When feeding on heavy timber, they frequent only the edges, where the injurious insects are invariably the most plentiful.

Abundance.

Owing to the fact that they go in flocks and are therefore not so evenly distributed as the Nuthatches, it is more difficult to determine their abundance. Although, on the average, about two were secured for every mile travelled, yet as they go in small flocks several were generally secured in an immediate vicinity. A flock of seven Chickadees is doubtless a fair average for each square mile, and in some parts of the State, especially the southeastern, I am sure that they are much more abundant in orchards than here.

Ability to Check Insect Pests.

If fifty-five insects were consumed per day by each bird, as will be shown to be the case, 385 would be consumed per day, and about 137,500 per year in each square mile. Thus upon the land surface of Michigan there will annually be about 8,000,000,000 insects destroyed by the Chickadees alone. Surely no mean number.

During the summer after the young have been reared, the number of individuals should be for some time at least tripled, giving us 20 to 25 per square mile. The census of 1890 shows that there are about 8,500,000 apple trees planted in Michigan, and of the fruit trees, apple orchards are the Chickadee's favorite haunt. This would give an average of about 150 trees per square

mile—enough for four ordinary sized orchards—or the average conditions existing in the better part of the State. As the worst period of insect attack is during and after the breeding season, this would allow six birds to each orchard.

Nineteen Chickadees contained a total of 830 insect forms, a large majority of which were noxious, and the remainder of a doubtful character as regards their value. Thus the Chickadees which it would be possible to secure in a fair sized orchard, a half-dozen, would consume at least 275 forms a day, but probably 350 would be a much fairer estimate, as the larvæ are quite rapidly digested and many were so finely divided as to render numerous individuals wholly indistinguishable. Now if these birds could be persuaded to nest here and rear their young, which would probably average five in number, 1200 insects would be required per day to feed the young and old birds. Professor Forbush states that 5000 canker-worms will strip a *large* apple tree. Thus the number of insects eaten would be sufficient to prevent the defoliation of a *large* tree every four days, and young trees in proportion, with no expense whatever to the farmer for labor or insecticides. Of course these compilations are largely of a speculative character, as unfortunately we have but few experiments and little accurate data, but they cannot but be highly suggestive.

Value of Winter Residence.

But this fails to take into account the large number of eggs eaten in the winter, from which the larvæ, when hatched, might be impossible to destroy—as shown by the observations of Prof. Forbush cited above. Again, the destruction of adult insects and larvæ during the winter is far more valuable than later, because they are mostly the ones which lay the eggs in the spring and thus keep up the life cycle. There are but few other birds present here in winter to perform this work, and these two birds also secure their food from places where no other birds present at that time of year would search for it. In this they form a well balanced couple, the Nuthatch securing his food from the rough bark of the main trunk while the Chickadee pecks away at

the small buds and joints, loose bark, etc., of the smaller, smooth limbs. In addition, it can be said in favor of both these birds that they are inclined to remain in one vicinity and do not wander far from it, but steadily and thoroughly work over one feeding ground.

Possibility and Desirableness of Partial Domestication.

Both these birds are very easily approached, and may readily be lured to orchards or shade trees,—they are quite common upon the shade trees of Lansing and, as stated before, are very tame on the campus.

It is, then, self-evident, that by every means they should be encouraged, by placing food for them till they become at home, by erecting suitable nesting sites, and by careful protection, to feed and nest in the orchards. It might be interesting to try the experiment of destroying as many old Woodpecker holes as possible and by placing suitable nesting sites in the orchard to thus entice them. Yet, in general, the old holes in which they nest should not be all cut out when securing fire wood, but a sufficient number be allowed to remain. If the farmer will take a very little time now and then in thus attracting these feathered insect-destroyers to his orchard, he will soon find very little if any need for insecticides except for extraordinary attacks. "An ounce of prevention is worth a pound of cure" is truly more applicable to the destruction of insect life than to almost any other phenomena.

NOTES ON CERTAIN SPECIES OF MEXICAN BIRDS.

BY E. W. NELSON.

THE WORK done on Mexican birds for the Biological Survey of the U. S. Department of Agriculture has added to the previously known range of many species and furnishes material for elucidating the relationships of others.